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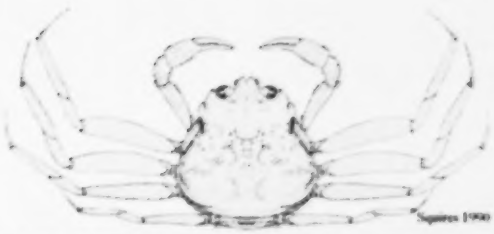


WESTERN CAPE BRETON SNOW CRAB (AREA 19)

Background

Snow crab (Chionoecetes opilio) is a crustacean like lobster and shrimp, with a flat, almost circular, body and five pairs of spider-like legs. The hard outer shell is periodically shed in a process called moulting. After moulting, crabs have a soft shell for a period of 8 to 10 months. Soft-shelled crab is defined by shell hardness (<68 durometer units). The term "white crab" describes both new-soft and clean hard-shelled crab (conditions 1 and 2 respectively).

Unlike lobsters, snow crabs do not continue to moult throughout their lives. Females stop growing when they acquire a wider abdomen for carrying eggs. This occurs at shell widths less than 95mm. Male snow crab stop growing when they acquire large claws on the first pair of legs. This can occur at shell widths between 40 and 150 mm. Female crab produce eggs that are carried beneath the abdomen for approximately 2 years. The eggs hatch in late spring or early summer and the newly-hatched crab larvae spend 12-15 weeks floating freely in the water column. At the end of this period, they settle on the bottom. It takes at least 8-9 years for snow crab males to reach legal size.

The minimum legal shell width is 95mm, and female crabs are not kept by industry. Baited traps, constructed of wire or tubular steel, are used to catch crab, mainly on mud or sand-mud bottoms at temperatures ranging from -0.5 to 4.5°C and depths ranging from 50 to 280m. The fishery takes place in late summer in Area 19. Neither soft-shelled nor white crabs are harvested.

In 2003, Area 18 was integrated to Area 12 and a 5 nautical miles no fish buffer zone was implemented between Area 18 and Area 19. Management of this fishery is based on quotas and effort controls (number of licenses, trap limits and season).

Snow crab management Area 19 and the southeastern part of Area 12 and the 5-mile buffer zone (shaded area).

Summary

- Crabs in management Area 19 are part of a larger biological population including crab in adjacent Areas 12 and F. Any biological key events observed in the southern Gulf of St. Lawrence may have subsequent impacts on the stock condition in Area 19.
- The 2005 landings in Area 19 were 2,827 t (quota of 2,878 t)
- The CPUE remained the same in 2005 as in 2004 at 69 kilograms per trap haul (kg/th).
- The 2005 fall survey biomass index of commercial-sized crabs was 3,421 t (2,220 t – 5,045 t), which represents a decrease of 17% compared to the 2004 fall estimates of 4,113 t (3,042 t – 5,440 t).
- The recruitment to the fishery estimated to be 1,484 t (720 t – 2,724 t) represents

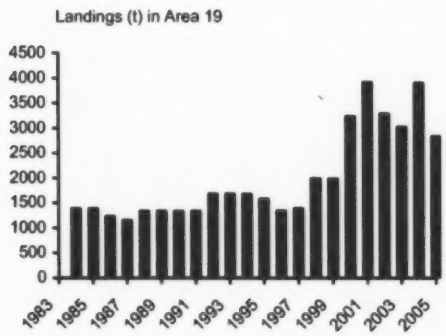
Canada

43% of the 2005 fall survey commercial biomass index.

- The prerecruits ≥ 56 mm CW (R-4, R-3 and R-2) observed in the 2005 trawl survey slightly increased in Area 19 compared to 2004, which may indicate an increase in the commercial biomass index in the near future if these crabs stay within the zone after reaching the legal size.
- The commercial biomass index estimates based on the fall trawl survey may not reflect the fishable stock at the time of the fishery 8-10 months later, mainly because of a dynamic movement of commercial-sized adult males that occurs in Area 19 (a relatively small fishing area) and adjacent fishing Areas 12 and F.

The Fishery

The 2005 regular fishing season opened on July 14 and ended on September 06 with reported landings of 2,827 t (quota of 2,878 t).



The fishery indicators were generally good during the 2005 fishing season. The CPUE in 2005, 68.7 kg/trap haul (kg/th), remained at the same level as 2004 (68.9 kg/th) while the fishing effort decreased from 56,517 trap hauls (th) in 2004 to 41,512 th in 2005. The annual percentage of soft-shelled crabs slightly increased in 2005 (9.8%) compared to 2004 (7.1%). The mean size of commercial adult males increased from 113.9 mm CW in 2004 to 116.1 mm CW in 2005.

The fishing effort during the 2005 season was concentrated mostly in the southern and central parts of Area 19 where the highest CPUEs were observed.

Carapace condition was estimated from sea samples taken from the 2005 fishery. The percentage of commercial-sized adult males with carapace conditions 1 and 2 in commercial catches has continuously decreased from 2000 (16.6%) to 2003 (4.9%), but increased to around 15.0 % in 2004 and 2005. The percentage of crabs with carapace condition 3 has increased from 26.9% in 2000 to 80.4% in 2003, decreased to 69.5% in 2004 but increased to 73.9% in 2005. Conditions 3 and 4 combined, represented 85.5% of the catches in 2005. The percentage of commercial-sized adult males with carapace condition 5 remained low in 2005.

Percentage of the Catch of Commercial-Sized Adult Crabs by Carapace Condition

Condition	Description	2000	2001	2002	2003	2004	2005
1 & 2	White Crab	16.5	8.3	8.7	4.9	15.7	15.2
3	Intermediate	26.9	31.3	70.2	80.4	69.5	73.9
4	Old Crab	55.8	60.1	20.6	14.5	14.3	10.6
5	Very Old Crab	0.8	0.3	0.5	0.2	0.5	0.3
Total		100	100	100	100	100	100

Quotas (t), Landings (t), Fishing Effort (number of trap hauls), and Catch Performance in Area 19

	2001	2002	2003	2004	2005
Quota	3,912	3,285	3,106	5,092	2,878
Landings	3,910	3,279	3,103	3,894	2,827
Effort	46,251	43,226	29,952	56,517	41,512
CPUE	88.5	72.3	103.6	68.9	68.7
Mean size (mm)	114.3	110.0	114.0	113.9	116.1
Soft crab (%)	6.5	3.5	3.7	7.1	9.8

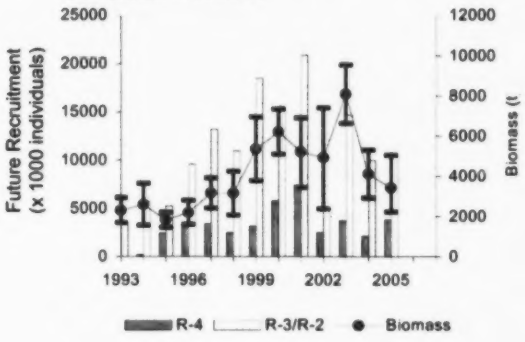
Resource Status

Conclusions about stock status are primarily based on a trawl survey conducted from July to September, which provides an index of the size of the exploitable biomass (hard-shelled adult males of legal size) remaining immediately after the fishery. It also provides estimates of soft-shelled adult males larger than 95 mm CW (R-1) that will

be new recruits to the fishery the following fishing season. Abundance indices are estimated for males as future recruitment to the fishery (R-4, R-3 and R-2) and females (pubescent and mature) as future and current spawning stock abundance. The terms R-4, R-3 and R-2 represent male crabs with a carapace width range of 56-68, 69-83, and larger than 83 mm CW, respectively. A portion of these crabs could be available to the fishery in 4, 3 and 2 years, respectively. The term pubescent refers to females with a narrow abdomen and orange gonads that will molt to maturity and mate the following year and become primiparous females (first brood). The term 'multiparous' refers to females which are carrying a brood for the second time or more. The term 'mature female', includes primiparous and multiparous females (excluding senile females). An abundance index of total adolescent males larger than 56 mm CW (R-4, R-3 and R-2 combined) is also estimated and used as an index of the incidence of soft-shelled crabs that may enter commercial traps the following fishing season.

The 2005 fall trawl survey indicates a commercial biomass index at the time of the survey of 3,421 t (2,220 t – 5,045 t), which represents a decrease of 17% compared to the 2004 fall trawl survey estimate of 4,113 t (3,042 t – 5,440 t). The recruitment to the fishery at the time of the 2005 fall survey estimated to be 1,484 t (720 t – 2,724 t) represents 43% of the commercial biomass index.

Survey biomass index (t) with a 95% confidence interval and abundance indices of future recruitment in Area 19



However, the commercial biomass index estimates based on the fall trawl survey may not reflect the fishable stock at the time of the fishery 8-10 months later. There is a dynamic movement of commercial-sized adult males that occurs in Area 19 (a relatively small fishing area) and adjacent fishing Areas 12 and F, such that in some years, the biomass supporting the fishery in the year after the survey was much larger than estimated by the survey, and in other years, it was smaller.

In 2004, the fishery was prematurely closed, with reported landings of 3,894 t (77% of the quota of 5,092 t), despite the fact that the 2003 fall survey estimated the highest commercial biomass index (8,083 t) ever recorded in that zone. However, towards the end of the fishing season, catch rates were declining, the incidence of soft-shelled crab in catches was increasing, and there was uncertainty about possible emigration out of Area 19 by biomass that had contributed to the survey estimate the preceding fall. By comparing the commercial biomass index from the 2003 fall survey done after the fishing season and the 2004 June trawl survey conducted few days before the regular fishing season, the commercial biomass index decreased by 42% from 8,083 t in fall 2003 to 4,712 t in June 2004. In contrast, a 45% increase in the commercial biomass index was observed between the 2004 fall survey estimates (4,113 t) and the 2005 June survey (5,981 t). These differences in commercial biomass indices between the fall (after the fishery) and spring (just few days before the fishery) trawl surveys show the difficulty in estimating adequately the commercial biomass index for the July fishery based on the fall survey.

Given the size frequency distribution observed in survey catches, a decline in commercial biomass index is expected in Area 12 until 2010, accompanied by a contraction of range of commercial-sized adult crab distribution into the Bradelle Bank area. Consequently, the abundance of commercial-sized adult males in Area 19 may be negatively affected to the extent that

commercial crab show a net migration from Area 12 to 19 when densities are higher in Area 12, or from Area 19 to 12, when densities are higher in Area 19.

Sources of Uncertainty

A change in survey vessels used to conduct the trawl survey in Area 19 occurred from 1990 to 1998 (Emy-Serge D), from 1999-2002 (Den C. Martin) and since 2003 (Marco-Michel). Without a comparative study to evaluate the catch efficiency between the three vessels, the commercial biomass index from the time series cannot be compared. The catch efficiency of the trawl needs further investigation.

The magnitude of unreported landing and handling mortality of white crab are unknown, and may be a source of uncertainty in reconciling survey and fishery results from one year to the next.

Research is needed to resolve uncertainties regarding many aspects of the snow crab biology such as growth pattern, skip molters, and reproductive output.

Movement of adult crab in and out of the surveyed areas is a major source of uncertainty in evaluating stock dynamics and managing the fishery. The role of environmental factors, density dependent processes in both Area 19 and adjacent areas (12 and F), and anthropogenic factors such as seismic survey sounds in affecting the net movement of crab into and out of Area 19 needs to be better understood.

Since the beginning of the trawl survey in Area 19, a discrepancy was observed between the observed and expected values of the commercial-sized adult male abundance. This discrepancy has changed from being positive during 1998 to 2003 to being negative in 2004 suggesting an emigration of commercial-sized adult males outside Area 19. A concentration of biomass straddles the boundaries of Areas 12 and 19, therefore seasonal movements of crab between these areas will affect the biomass level in any given area.

Two trawl surveys (the regular fall and a pre-fishery June surveys) will help to quantify the incoming or outgoing migration of commercial-sized adult males into Area 19 and reduce uncertainty about the appropriate exploitation rate for the stock component that is supporting the fishery.

The relationships between the biomass of mature females, stock recruitment and the effect of the ratio of adult males of various ages to mature females on stock productivity need further investigation. Computer simulations of current and post-larvae distribution should be continued to determine the relationship between the spawning stock and the future recruitment to stock units in the periphery and outside the southern Gulf of St. Lawrence.

Biological Considerations

Biological characteristics such as **recruitment and growth pattern** in the southeastern Gulf seem to differ from those in the southwestern Gulf. These biological parameters need further investigations.

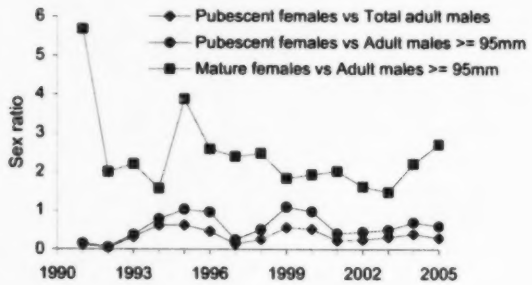
The **reproductive potential of the stock** for Area 19 is evaluated as part of larger biological unit that also includes Area F and part of Area 12. This entire area is considered as a unit of the southeastern Gulf of St. Lawrence.

In this large unit, the abundance index of the pubescent females increased from 8.3 million in 2001 to 14.5 million in 2003 and then decreased to 10.1 million of individuals in 2005. The abundance index for the **spawning stock** (mature females) has decreased from 86.2 million in 2002 to reach 66.8 million in 2004, but has since increased to 89 million in 2005.

The **sex ratio**, within the southeastern Gulf, between pubescent females and all adult males or adult males ≥ 95 mm CW has always been close to or less than 1 female

to 1 male (1F:1M) since 1991. For the spawning females, the ratio was skewed towards female dominance (6F vs. 1M in 1991 and 4F to 1M in 1995). Except for these two years, the ratio varied between 3F:1M (1997-1999) and 2-1.5F:1M (1992-1994, 2000-2004). The sex ration between these two groups was 2.7F:1M in 2005.

Sex ratio between different categories of females and males in the southeastern Gulf of St. Lawrence



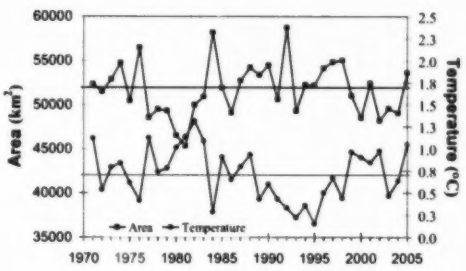
Close monitoring of the key events on population reproductive output (e.g., sex ratio, fecundity, recruitment to the early benthic stages) is necessary to detect any anomalies on the quality and quantity of the spawning stock and subsequent recruitment.

Ecosystem Considerations

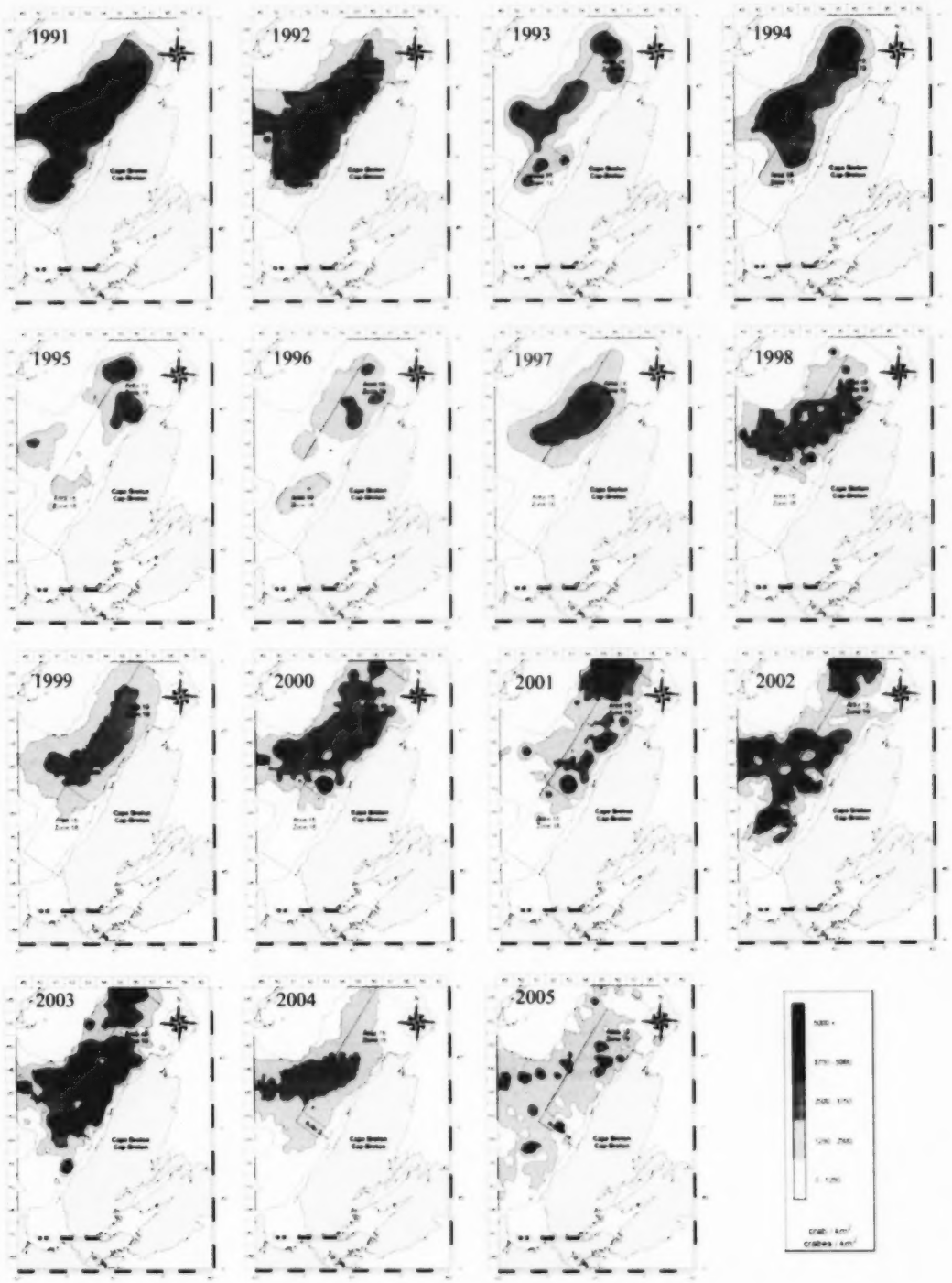
Environmental factors, such as water temperature, can affect the molting and reproductive dynamic as well as the movement of snow crab. Chassé et al. (2006) reported that the bottom temperatures over most of the southern Gulf of St. Lawrence are typically less than 3 °C, which is considered suitable thermal habitats for snow crab. Chassé et al. (2006) reported that the bottom temperatures in area 19 are typically 1°-2 °C warmer than the traditional crab grounds in Area 12.

Near-bottom temperatures in the shallower part of Area 19, during 2005, were observed to be warmer than the long-term (1971-2000) while the deeper part was slightly cooler than average but show a slight increase in temperature relative to 2004. When considered globally, the conditions in 2005 for Area 19 were warmer than normal. The cooler coastal water is consistent with a significant increase in the Gulf-wide snow crab habitat index (area of the bottom covered by water temperatures between –1 and 3 °C). The habitat index is now above the long-term average. However, the mean temperature within the habitat area in 2005 also significantly increased compared to 2004; it is an unusual situation as the two time series are usually negatively correlated. The 2005 mean temperature is above the long term mean, reaching a level similar to the ones observed during the 1999-2002 warm period and is the highest of the last 23 years. With this increase, the temperature conditions are not considered to be as favorable for snow crab as the mean core-index temperature is higher than normal, although the habitat index itself is above the normal.

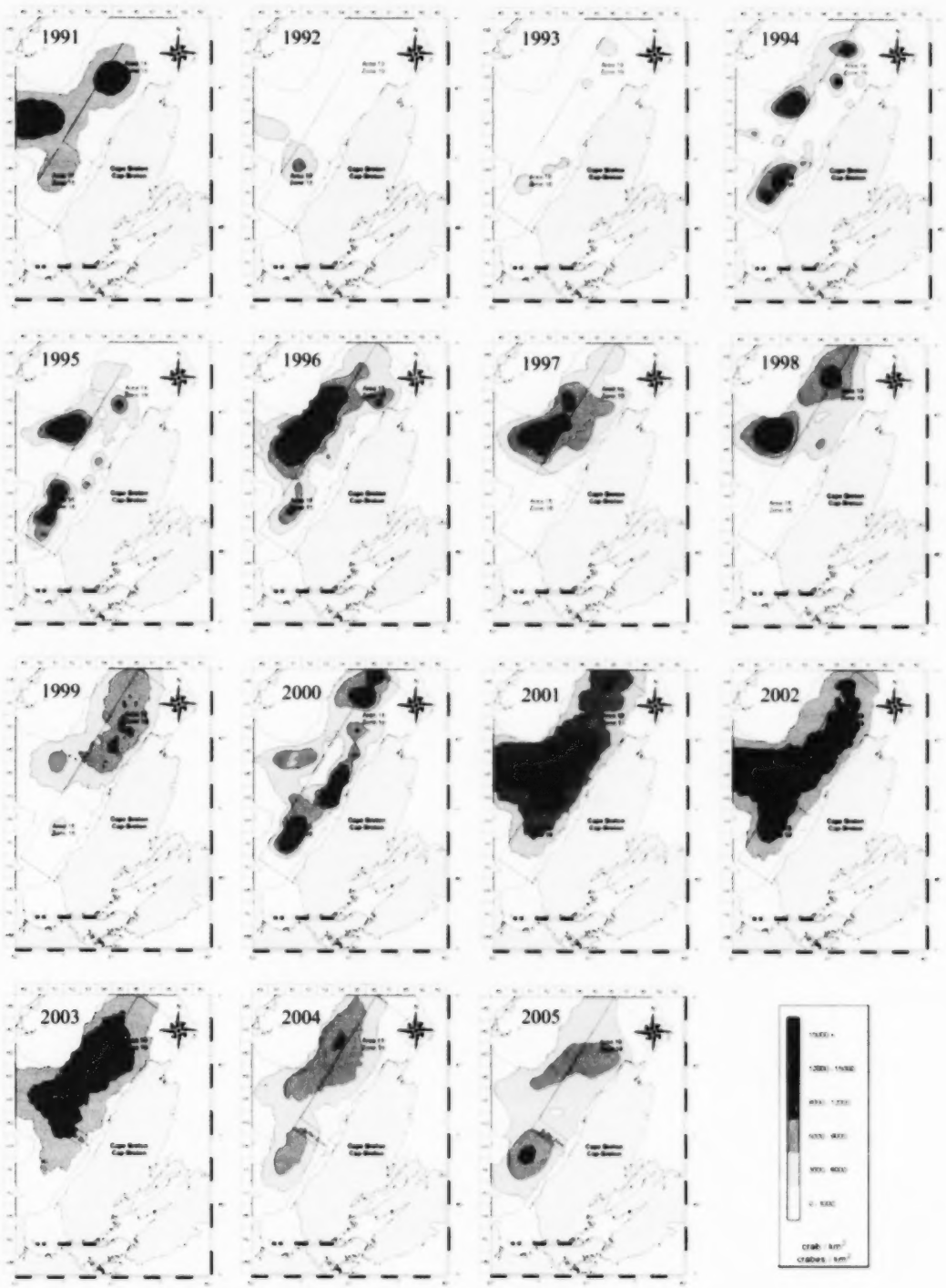
Snow Crab Habitat Area and Core Temperature Indices in the Southern Gulf



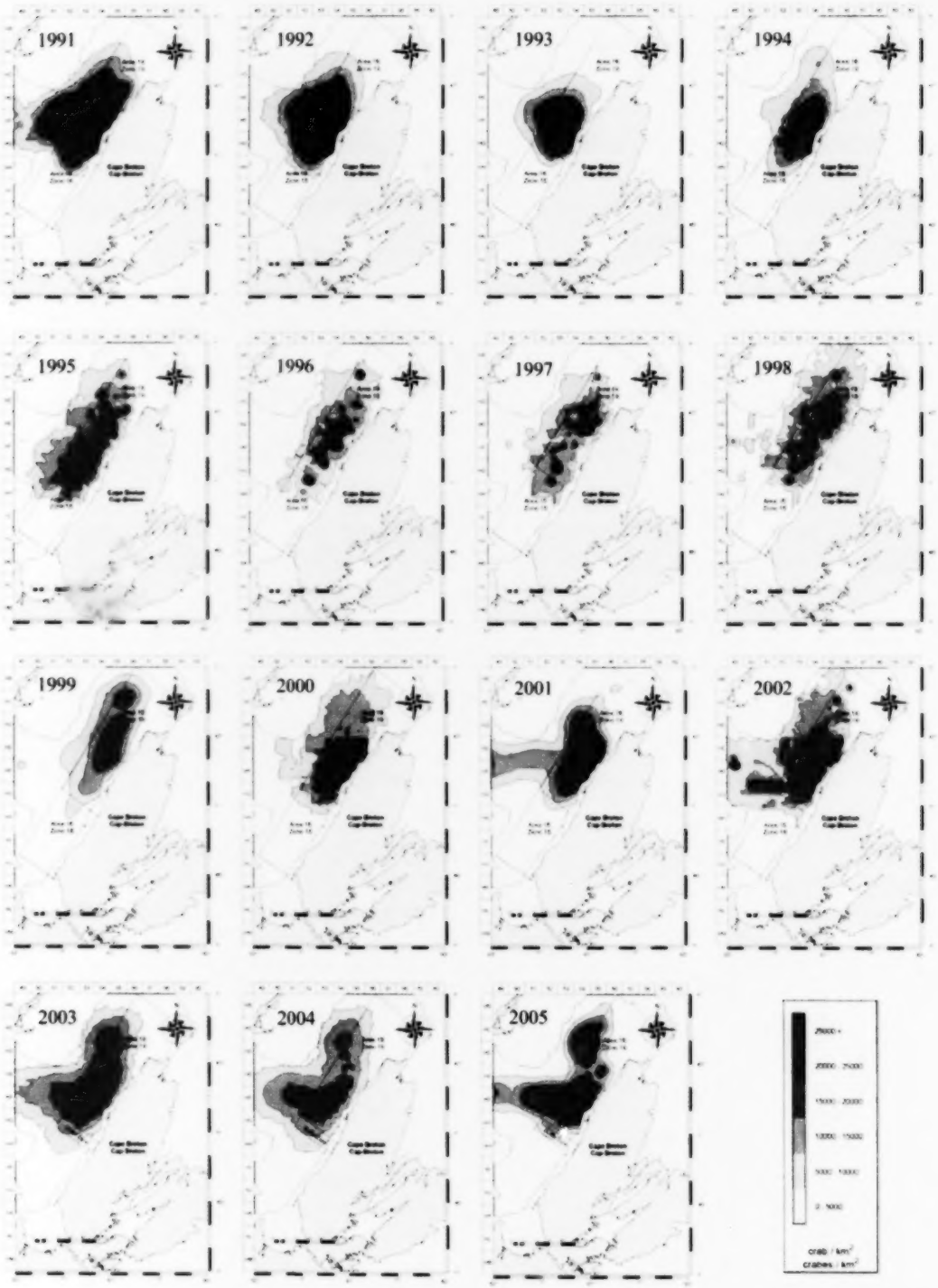
Density (crab/km^2) Contours of Adult Male Crab ≥95mm CW



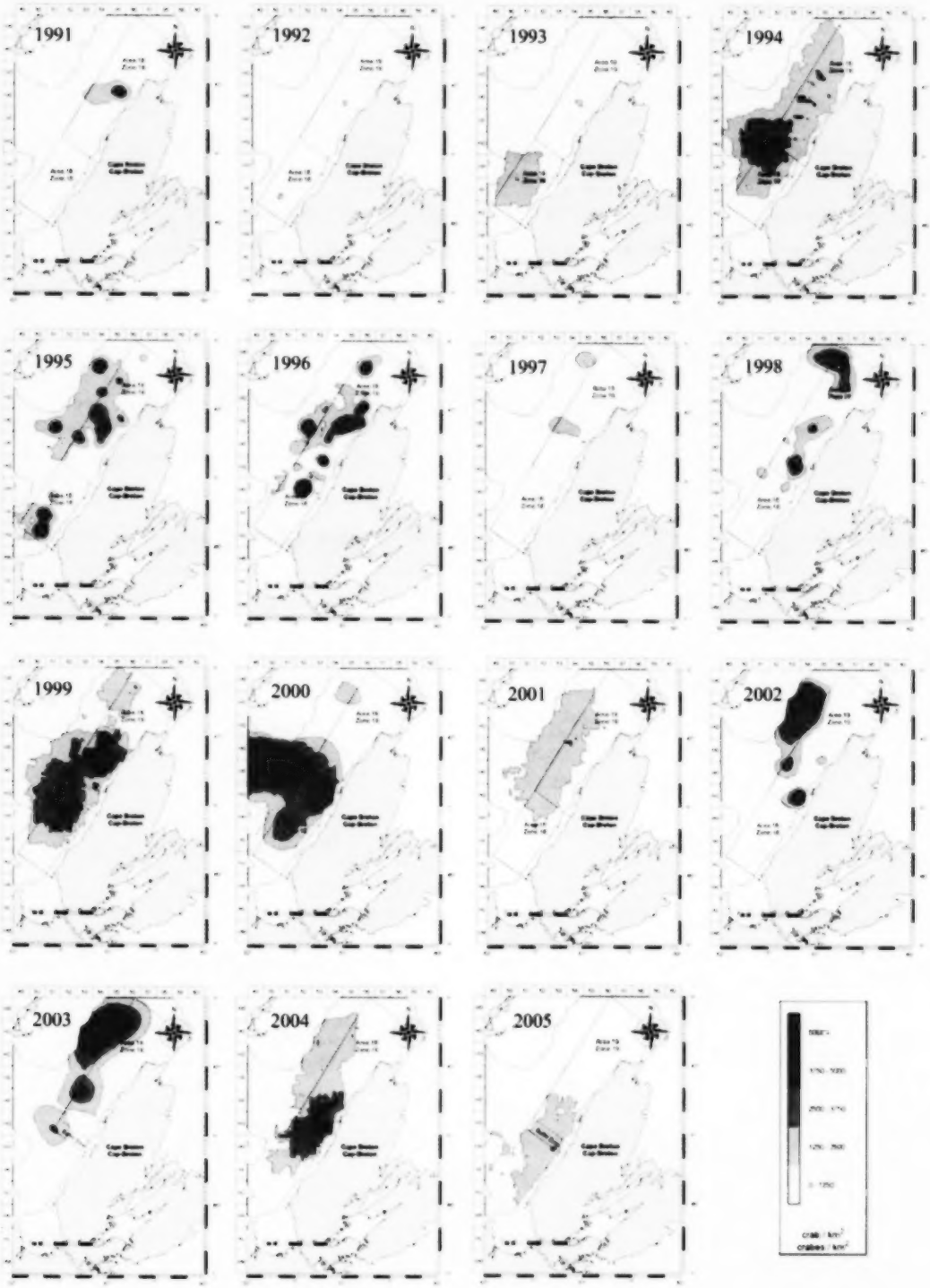
Density (crab/km^2) Contours of Adolescent Male Crab ≥56mm CW



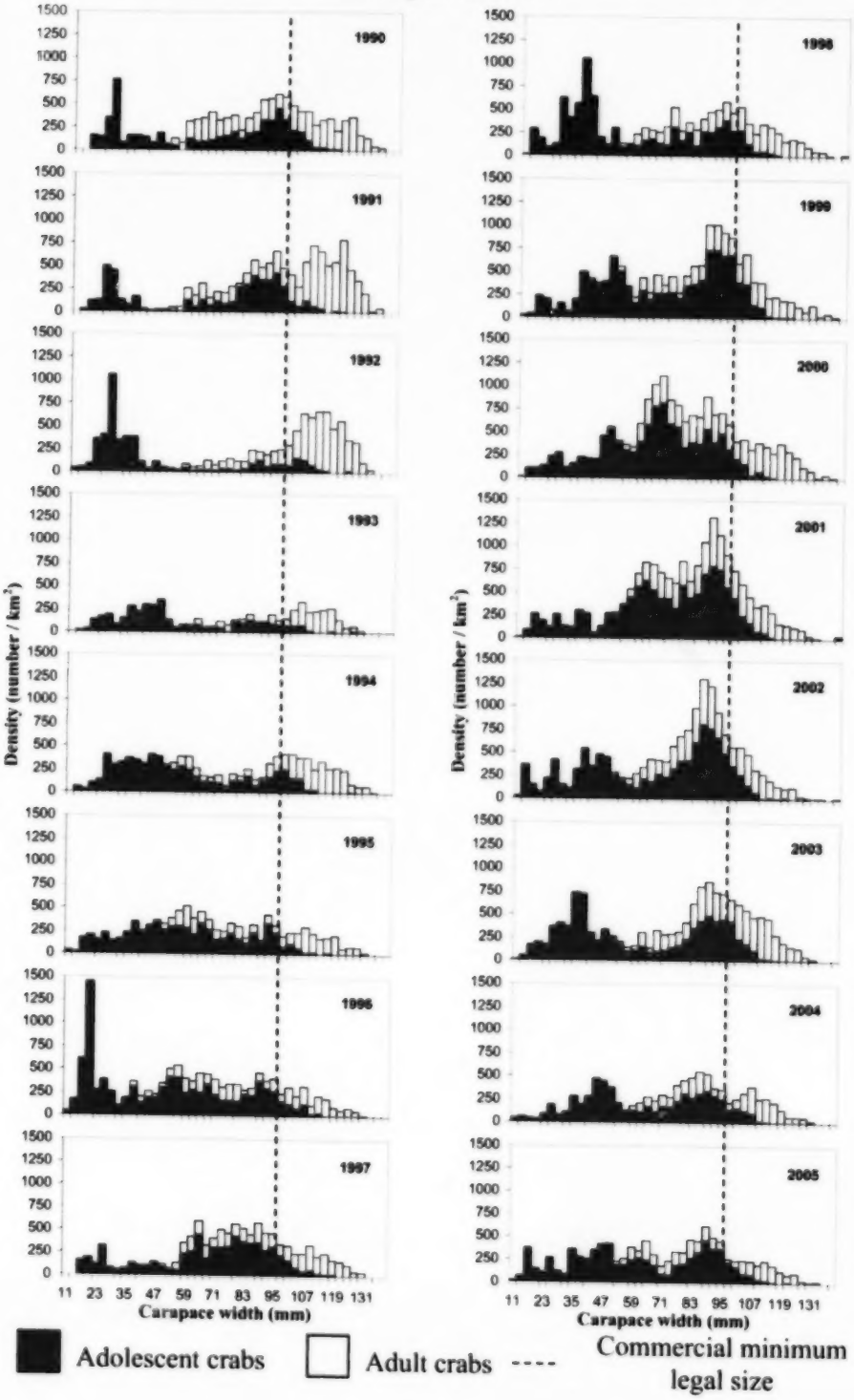
Density (crab/km^2) Contours of Mature Females



Density (crab/km^2) Contours of Pubescent Females



Size Frequency Distributions of Male Crab Sampled During the Trawl Survey in Area 19



Outlook

The prerecuits ≥ 56 mm CW (R-4, R-3 and R-2) from the 2005 fall survey slightly increased in Area 19 compared to the 2004 fall estimates, which may indicate an increase in the commercial biomass index for the coming years if these crabs stay within the zone after reaching the legal-size. However, the commercial biomass index and the abundance of precrecruits ≥ 56 mm CW (R-4, R-3 and R-2) in Area 12 are decreasing. This may affect the migration of commercial-sized adult males between Areas 12 and 19.

For 2006, there are expected to be substantial biological benefits from maintaining a soft-shelled crab protocol to protect the future recruitment to the fishery.

Management Considerations

The commercial biomass index estimated from the 2005 September trawl survey may not reflect the availability of commercial biomass at the beginning of the 2006 fishing season, depending on the fishery and stock dynamics outside Area 19. It would be beneficial to conduct a June trawl survey just before the opening of Area 19 fishery to estimate the level of commercial biomass prior to the fishery and re-adjust the fishing strategy according to the biomass and proportion of carapace stages observed in that particular survey.

Management measures such as a soft-shelled protocol, should be maintained in order to protect the future recruitment to the fishery and the reproductive potential of the stock.

Continuing the trawl survey is essential to provide annual abundance and commercial biomass indices, detect any anomalies in reproductive potential of the stock and estimate the annual instantaneous mortality (natural mortality, emigration and immigration). The current trawl survey is considered the best tool in assessing the snow crab stock in the southern Gulf of St. Lawrence.

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